U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Astragalus schmolliae

Common Name:

Schmoll milk-vetch

Lead region:

Region 6 (Mountain-Prairie Region)

Information current as of:

12/31/2010

Status/Action

___ Funding provided for a proposed rule. Assessment not updated.

___ Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

___ New Candidate

_X_ Continuing Candidate

___ Candidate Removal

___ Taxon is more abundant or widespread than previously believed or not subject

___ Taxon not subject to the degree of threats sufficient to warrant issuance of

___ Range is no longer a U.S. territory

___ Insufficient information exists on biological vulnerability and threats to s

___ Taxon mistakenly included in past notice of review

___ Taxon does not meet the definition of "species"

___ Taxon believed to be extinct

___ Conservation efforts have removed or reduced threats

Petition Information

___ Non-Petitioned

_X_ Petitioned - Date petition received: 07/30/2007

90-Day Positive:08/18/2009

12 Month Positive:12/15/2010

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing? **Yes**

Explanation of why precluded:

We find that the immediate issuance of a proposed rule and timely promulgation of a final rule for this species has been, for the preceding 12 months, and continues to be, precluded by higher priority listing actions (including candidate species with lower LPNs). During the past 12 months, the majority our entire national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements; meeting statutory deadlines for petition findings or listing determinations; emergency listing evaluations and determinations; and essential litigation-related administrative and program management tasks. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken over the past 12 months, see the discussion of Progress on Revising the Lists, in the current CNOR which can be viewed on our Internet website (http://endangered.fws.gov/).

Historical States/Territories/Countries of Occurrence:

- **States/US Territories**: Colorado
- **US Counties**:County information not available
- **Countries**:Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories**: Colorado
- **US Counties**: Montezuma, CO
- **Countries**:Country information not available

Land Ownership:

Land ownership is approximately 50 percent federal and 50 percent tribal. *Astragalus schmolliae* habitat collectively occupies approximately 1,619 ha (4,000 ac) in Mesa Verde National Park (MEVE) and on the Ute Mountain Ute Tribal Park (Tribal Park). About 809 ha (2,000 ac) are in MEVE on Chapin Mesa including Fewkes and Spruce Canyons, on the West Chapin Spur, and on Park Mesa (CNHP 2010, pp. 12–-19; Anderson 2004, p. 25, 30; Nelligan 2010, p.1). Occupied habitat on Chapin Mesa in the Tribal Park south of MEVE probably covers another 809 ha (2,000 ac), where surveys have not been done (Anderson 2004, p. 6; Friedlander 1980, p. 53; CNHP 2010, pp. 20-21).

Lead Region Contact:

Office of the Regional Director, Sarah Fierce, 303 236-4388, Sarah_Fierce@fws.gov

Lead Field Office Contact:

Western Colorado ESFO, Ellen Mayo, 9702432778 14, ellen_mayo@fws.gov

Biological Information

Species Description:

Astragalus schmolliae plants are upright perennials, 30 to 60 cm (12 to 24 in.) tall with one to several stems branching from an underground root crown. Its leaves are typical of many of the legumes, with 11 to 20 small leaflets on a stem. Leaves and stems are ash-colored due to a covering of short hairs. Flowers are creamy white, on upright stalks that extend above the leafy stems. The fruit is a pod, 3 to 4 cm (1 to 1.5 in.) long, covered with flat, stiff hairs, pendulous and curving downward (Barneby 1964, pp. 277–278). The deep taproot grows to 40 cm (16 in.) or more (Friedlander 1980, pp. 59–62).

Taxonomy:

Astragalus schmolliae was first collected in Montezuma County, southwestern Colorado, in 1890. It was formally described as a species in 1945, when C.L. Porter named it after Dr. Hazel Marguerite Schmoll (Porter 1945, pp. 100–102; Barneby 1964, pp. 277–278; Isely 1998, p. 417). *A. schmolliae* is a member of the family Fabaceae (legume family).

Habitat/Life History:

Astragalus schmolliae plants emerge in early spring and usually begin flowering in late April or early May. Flowering continues into early or mid-June (Friedlander 1980, p. 63, Peterson 1981, p. 14). Fruit set begins in late May and occurs through June, and by late June most fruits have opened and released their seeds, while still attached to the plant. The typical plant lifespan of A. schmolliae is unknown, but individuals are thought to live up to 20 years (Colyer 2002 in Anderson 2004, p. 11). During very dry years, as observed in 2002, the plants can remain dormant with no above-ground growth (Colyer 2003 in Anderson 2004, p. 11). Most of the plants produce above-ground shoots and flower profusely during growing seasons following wet winters.

Astragalus schmolliae requires pollination by insects to set fruit. Flowers require a strong insect for pollination, such as a bumblebee, because the insect must force itself between the petals of the butterfly-shaped flowers. Pollinators observed on *A. schmolliae* include several species of bumblebees (Bombus spp.) and beeflies (Bombylius spp.) (Friedlander 1980, p. 63).

The habitat for *Astragalus schmolliae* is mature pinyon-juniper woodland of mesa tops in the Mesa Verde National Park (MEVE) area at elevations between 1,981 to 2,286 meters (6,500 to 7,500 feet) (Anderson 2004, p. ii). The plants are found in both sunny and shaded locations (Peterson 1981, p. 12), primarily on deep, reddish loess soils, and are generally less common near cliff edges and in ravines where the soil is shallower. No *A. schmolliae* plants are found in the mountain shrublands at the upper elevations on MEVE.

Historical Range/Distribution:

Same as current range.

Current Range Distribution:

Astragalus schmolliae habitat collectively occupies approximately 1,619 ha (4,000 ac) in MEVE and on the Ute Mountain Ute Tribal Park (Tribal Park). About 809 ha (2,000 ac) are in MEVE on Chapin Mesa including Fewkes and Spruce Canyons, on the West Chapin Spur, and on Park Mesa (CNHP 2010, pp. 12–19; Anderson 2004, p. 25, 30; Nelligan 2010, p.1). Occupied habitat on Chapin Mesa in the Tribal Park south of MEVE probably covers another 809 ha (2,000 ac), where surveys have not been done (Anderson 2004, p. 6; Friedlander 1980, p. 53; CNHP 2010, pp. 20–21).

The distribution of *Astragalus schmolliae* is typical of narrow endemics, which are often common within their narrow range on a specific habitat type (Rabinowitz 1981 in Anderson 2004, p. 3). However, *A. schmolliae* is unusual because similar habitat is widespread on nearby mesas where the species has not been found. Thus, the causes of its rarity are unknown. Its distribution may be limited by habitat variables that are not yet understood (Anderson 2004, p. 8).

On Chapin Mesa, most of the Schmoll's milkvetch plants are on higher ground near the border with MEVE. Plants are most abundant and many recruits are observed where they are shaded by pinyon pine. Plants become increasingly sparse and no recruits are seen on the lower southern tip of Chapin Mesa, where there is less tree cover and the ground is warmer and drier (Natori and Clow 2011, pers. comm.).

Population Estimates/Status:

The total estimated number of *Astragalus schmolliae* plants in MEVE was 482,786 in 2001 before the Long Mesa fire described in factor A. In 2003 after the fire the total estimated number of plants was 294,499 (CNHP 2010, pp. 1–21; Anderson 2004, p. 6, 30). Recent population estimates are not available for MEVE. Abundant plants were observed on the tribal land in 1987 (Colyer 2002, in Anderson 2004, p. 4; CNHP 2010, p. 21). We have no estimate of plant numbers on the Tribal Park because no inventories have been completed (Clow 2010, pers. comm.).

Astragalus schmolliae is considered critically imperiled globally (G1) by the CNHP, a rank used for species with a restricted range, a global distribution consisting of less than five occurrences, a limited population size, or significant threats (CNHP 2006, p. 1).

Threats

A. The present or threatened destruction, modification, or curtailment of its habitat or range:

The following potential factors that may affect the habitat or range of *Astragalus schmolliae* are discussed in this section, including: (1) Wildfire; (2) invasive nonnative plants; (3) post-fire mitigation; (4) wildfire and fuels management; (5) development of infrastructure; (6) drought and climate change.

Wildfire

Six large wildfires burned within MEVE between 1989 and 2003, and extensive portions of those burned areas have been invaded by nonnative plant species (weeds) (Floyd et al. 2006, p. 247). Small,

lightning-caused fires are frequent in MEVE. The annual average number of fire starts between 1926 and 1969 was 5 per year, which increased to 18 per year between 1970 and 1997. Most of the fires started in the pinyon-juniper woodlands and burned less than 1 ha (2.5 ac). The southern half of MEVE was covered with dense, old-growth pinyon-juniper woodlands that had not burned for several centuries. However, the 20th century has seen several wildfires that burned extensive portions of these pinyon-juniper woodlands (Floyd et al. 1999, p. 149). Best estimates for "natural" fire turnover times in MEVE are about 100 years for shrubland vegetation and about 400 years for pinyon-juniper vegetation. Although the disturbance regime for this system apparently remains within the historical range of variability, the recovery processes following fire have been dramatically altered from historical processes (Floyd et al. 2006, p. 248). Recurrent fires favor clonal, resprouting shrub species such as *Quercus gambelii* (gambel oak), *Amelanchier utahensis* (Utah serviceberry), *Symphoricarpos oreophilus* (mountain snowberry), *Fendlera rupicola* (cliff fendlerbush), and Rhus trilobata (three-leaf sumac), and gradually eliminate the fire-sensitive pinyon and juniper (Floyd et al. 2000, p. 1667, 1677). A. schmolliae does not grow in the shrub-dominated areas of MEVE now, and we cannot predict the long- term success of the species following removal of the pinyon-juniper overstory.

From July 29 to August 4, 2002, the Long Mesa Fire burned 1,053 ha (2,601 ac) on Chapin and Park Mesas, which included about 306 ha (756 ac) of *Astragalus schmolliae* habitat (Anderson 2004, p. 28). Between 1996 and 2008, 308 ha (762 ac) of habitat were burned by wildfires, and 6 ha (15 ac), by prescribed burns (Nelligan 2010, p. 1). On Tribal Park habitat, several small fires appear to have burned a total of about 23 ha (57 ac) (Glenne 2010, map). Altogether, these recent fires have impacted about 21 percent of the total habitat for the species.

The average density per square meter of plants on monitoring plots in MEVE decreased 39 percent from 2001 to 2003 (Anderson 2004, p. 30, 37). Density declined in both burned and unburned transect segments between 2001 and 2003. The decline in density was slightly lower in burned transect segments than in unburned, but the difference in density in 2003 between burned and unburned transect segments was not statistically significant, suggesting that burning did not significantly impact plant mortality, nor did it result in any benefit to the species. Therefore, we do not believe that fire itself has direct negative effects that constitute a threat to *A. schmolliae*. The 39 percent decline in density in MEVE was attributed to the 2002 drought and prolonged dormancy, because the plants do not send up new growth during very dry years (Anderson 2004, p. 37).

No seedlings were observed in 2001 on burned or unburned habitat, but they were observed in 2003 throughout the range of *Astragalus schmolliae* in MEVE, except at the population on northern Park Mesa that was severely burned in 1996 (Anderson 2004, p. 39). There were no clear differences in seedling success between burned and unburned areas during early summer surveys, but survivorship of seedlings through their first summer could not be determined (Anderson 2004, p. 48). Viability of seeds collected in 2003 was between 94 and 100 percent (Anderson 2004, p. 49). The patterns of seed germination are suggestive of a species that maintains a persistent seed bank (Anderson 2004, p. 47). The longevity of seeds of *A. Schmolliae* is not known, but many legumes, including members of Astragalus, have seeds as long-lived as 97 years (Anderson 2004, p. 48). Recruitment appears to be highly episodic and is probably greatest in years that are moist in March through May (Anderson 2004, p. iv). Plants in areas burned in 2002 displayed higher reproductive effort and vigor, and produced approximately 241 times more seeds per plant than did plants in unburned areas. It is likely that this resulted in part from depletion of pollinator resources in unburned areas , because the post-fire flush of growth attracted more pollinators. Plants in areas burned in 1996 on Park Mesa had very high vigor in 2003 (possibly due to high soil nitrate levels after fire) but did not set fruit although flowers were produced and insect visitation was observed (Anderson 2004, p. iv).

Seed bank studies for other Astragalus species indicate that the group generally possesses hard impermeable seed coats with a strong physical germination barrier. As a result, the seeds are generally long-lived in the

soil and only a small percentage of seeds germinate each year (Morris et al. 2002, p. 30). However, we do not know if the seed germination strategy for other Astragalus species is comparable to that employed by *A. schmolliae*.

The growth habit of *Astragalus schmolliae* suggests that it is tolerant of fire, with its deep taproot and shallowly buried root crown, to which the plant dies back during winter months. Plants can resprout following a low-intensity fire if the root crown is not damaged (Floyd-Hanna et al. 1997, 1998). Reproductive effort and fecundity were clearly higher in areas burned in 2002, and vigor also appeared to be greater. However, net reproductive success in post-fire environments has not been monitored, so it is unclear whether fire effects have a negative or beneficial initial impact on *A. schmolliae*. While fire may confer some short-term benefits to plants in burned areas (possibly at the expense of reproductive success in unburned areas if depletion of pollinator resources is responsible for poor fecundity), it may have detrimental long-term impacts (Anderson 2004, p. 64).

We conclude that the direct effects of fire on *Astragalus schmolliae* are both positive and negative. Plants burn to the ground and then resprout the following spring if the fire is not too intense, but then have competition from weeds and grasses. We do not know whether net reproduction after fire is positive. Given the high frequency and volume of fires in the area it is highly likely that new fires will burn more of the habitat for *A. schmolliae*. All of the burned and remaining unburned habitat on MEVE and the Tribal Park is at risk of burning within the foreseeable future. Although we remain concerned about the potential impacts of recurring fires, the best available information indicates that the direct effects of wildfires do not pose a threat to *A. schmolliae*. However, the indirect effect of wildfire in facilitating invasion of the habitat by cheatgrass does pose a significant threat to the species (see Invasive Nonnative Plants for more discussion).

Invasive Nonnative Plants

As discussed above, the main threat to the species is the indirect effect of invasion by nonnative plant species (weeds). This invasion is facilitated by the increased frequency of burns as well as the clearing of areas within occupied *Astragalus schmolliae* habitat (CNHP 2006, p. 4). In MEVE, large wildfires that occurred earlier in the twentieth century (1934, 1959, 1972) were not associated with weed invasion (Floyd et al. 1999, p. 148), but the pinyon-juniper forests that have burned extensively in the past two decades are being replaced by significant invasions of weedy species, especially Bromus tectorum (cheatgrass), Carduus nutans (musk thistle), and Cirsium arvense (Canada thistle) (Floyd et al. 2006, p. 1). Carduus nutans was not found in either disturbed or undisturbed ground in 1980, but it was particularly invasive in burned areas of MEVE by 1999 and was aggressively invading areas occupied by *Astragalus schmolliae* (Floyd-Hanna et al. 1999, Romme et al. 2003).

Since 1996, MEVE has seen more large fires and more cumulative area burned than occurred during the previous 200 years (Romme et al. 2006, p. 3). This recent increase in fire activity is a result of severe drought conditions preceded by wet climatic conditions and increasing fuel load due to fire suppression in the pinyon-juniper woodlands, all coinciding with the natural end of a long fire cycle (Floyd et al, 2006, p. 247). A recent development in the post-fire habitat response is the remarkably rapid spread of cheatgrass. This weedy winter annual germinates in the fall, grows slowly during the winter, and then grows rapidly in the early spring. By early summer it has set seed and died, creating a continuous fuel bed of quick-drying, flashy fine fuel that can readily carry fire, even without wind. Cheatgrass has been in MEVE for many years. However, it was never widespread until 2000, when unusually warm dry summers and winters coupled with heavy fall rains allowed cheatgrass to rapidly expand its range, especially in places where fire or other disturbances have created bare ground (Romme et al. 2006, p. 3). Mature pinyon-juniper woodlands are highly vulnerable to post-fire weed invasion (Floyd et al. 2006, p. 254). Cheatgrass is now a dominant species in much of the area burned in MEVE (Romme et al. 2006, pp. 2–3) and it has inundated the burned and disturbed portions of *Astragalus schmolliae* habitat on Chapin Mesa (Hanna et al. 2008, p. 18). The highest infestation occurred in an area that had burned both in the 1996 and the 2002 fires on Park Mesa. This had been an old-growth pinyon-juniper woodland before the 1996 fire, and was seeded with native grasses.

After re-burning in 2002, this area was inundated by cheatgrass (Hanna et al. 2008, p. 9). Given the seasonal overlap of A. schmolliae seedling growth with the peak growth of cheatgrass, it is likely that the presence of cheatgrass in populations of *A. schmolliae* compromises its viability (Anderson 2004, pp. 60–61).

Landscape modeling of the effects of projected cheatgrass increase on fire frequency in MEVE indicates the potential for frequent reburning. Projections show a fire rotation of about 45 years for MEVE. Such a frequent disturbance regime would be far outside the historical range of variability for the pinyon-juniper, and would likely impact or eliminate many native plant species (Turner et al., p. 40). We have no data to indicate whether *Astragalus schmolliae* will successfully adapt to a post-fire habitat of open clearings between shrubs, and competition from cheatgrass, thistles, and native grasses versus a pinyon-juniper dominated community.

In 1980, cheatgrass was found in 8 percent of survey samples in picnic grounds and 0 percent of undisturbed samples (Friedlander 1980, pp. 75–76). We consider the invasion of nonnative weedy plants, particularly cheatgrass, to be a threat of high magnitude to *Astragalus schmolliae* because: (1) cheatgrass has invaded all of the burned and disturbed habitat of *A. schmolliae* in MEVE, covering at least 40 percent of its entire range; (2) it competes with seedlings and resprouting adult plants for water and nutrients; (3) no landscape scale successful control methods are available; and (4) the proven ability of cheatgrass to increase fire frequency, thereby facilitating further rapid spread, threatens both burned and previously unburned occupied habitat. We conclude that cheatgrass invasion is likely to cause fire frequency to increase, with the result that only small patches of undisturbed habitat will remain for *A. schmolliae* within MEVE. The extent of cheatgrass invasion on the Tribal Park is unknown, because no surveys have been completed.

Post-fire Mitigation

Various post-fire mitigation actions (aerial seeding of native grasses, and the control of weeds through mechanical removal, herbicides, and bio-control) have been effective in reducing the density of weeds after fire, but none of these techniques has prevented the weeds from becoming major components of the post-fire plant community. Post-fire mitigation activities were conducted in MEVE under the Burned Area Emergency Rehabilitation program in 1996 to 1997 to prevent weed invasion and severe erosion and to encourage native plant species. Aerial seeding of native grasses was applied intensively in the old-growth pinyon-juniper community. The density of Carduus nutans was significantly reduced by seeding in burned areas. There has been no evidence that the diversity of native forbs has declined by introducing native perennial grasses (Floyd et al. 1999, p. 155), but *Astragalus schmolliae* was not specifically monitored. Therefore, we are unsure if these efforts to prevent weed invasion negatively affect *A. schmolliae*.

Seeding of native grasses has not prevented the spread of cheatgrass into burned areas. Despite the seeding, cheatgrass invasion has increased (Floyd et al. 2006, p. 254). If cheatgrass continues to spread into recently burned areas in MEVE, it is likely to alter the previous regime of infrequent fires occurring during extremely dry periods to a new regime of frequent fires . Because the native flora is adapted to the historical fire regime, a change of this kind could produce rapid and irreversible degradation of native vegetation in the park (Floyd et al. 2006, p. 257). We believe this could be the case in *Astragalus schmolliae* habitat.

Releases of two biological control weevils on Carduus nutans have been highly effective in reducing the density, vigor, and net fecundity of the thistle plants in *Astragalus schmolliae* habitat on MEVE. Aerial seeding with native grass species has provided effective competition for some of the weeds and improved the proportion of native to invasive plants (Nelligan 2010, p. 2).

Post-fire weed control by aerial seeding of native grasses, mechanical removal, herbicides, and bio-control has reduced competition by invasive weeds other than cheatgrass, and there is little documentation of negative effects on *Astragalus schmolliae*. Because of this, we consider the impacts of these activities to be low, not rising to the level of a threat to the species.

Wildfire and Fuels Management

Wildfire management at MEVE includes the creation of fire breaks, fire lines, and staging areas, all of which remove the mature pinyon-juniper woodland habitat for *Astragalus schmolliae*. A cattle fence 4.2 km (2.6 mi) long separates the northern half of the species' habitat on MEVE from the southern half on the Tribal Park. MEVE created a fire break about 30 m (100 ft) wide along this fence by cutting all vegetation to ground level. The break covers about 14 ha (34 ac), or 0.9 percent of the species total habitat, at the center of distribution for *A. schmolliae*. On the Tribal Park side of the fence, the pinyon-juniper woodland is cut in a mosaic pattern, leaving trees and clumps of trees standing with cleared areas around them. This fire break covers about 189 ha (467 ac), or 12 percent of the species' total range. Response of *A. schmolliae* to the two different treatments has not been compared. Fire breaks also are created by prescribed burns. Mechanical removal and prescribed burning together have altered about 19 percent of the species total range, including the fenceline fire breaks described above (Nelligan 2010, p. 1).

The ecological conditions for *Astragalus schmolliae* within the cleared areas are different from its typical pinyon-juniper woodland habitat. Cleared areas are exposed to more sun and wind that dry the soil and the *A. schmolliae* seedlings. In addition to invasion by cheatgrass, removal of woody vegetation appears to result in competitive release of native grasses. In sites where no seeding has been done, removal of woody vegetation favors *Poa fendleriana* (muttongrass), the most common grass species on MEVE (Anderson 2004, p.73). This response is seen in mechanical fuels reduction areas on Chapin Mesa, where cover of P. fendleriana can approach 75 percent (Anderson 2004, p. 60). Density, reproductive effort and vigor of *A. schmolliae* appears low in these areas, although there are few quantitative data with which to compare density. Plants were growing among large, crowded bunches of P. fendleriana and appeared small and unhealthy (Anderson 2004, p. 73). This effect is probably due to competition with *P. fendleriana* for water and nutrients. On unburned Chapin Mesa south of MEVE, density of *A. schmolliae* was second only to *P. fendleriana*, as a dominant understory plant (Colyer 2002, in Anderson 2004, p. 7). This may indicate that *A. schmolliae* can recover from the initial impact of native grass competition following removal of the overstory woodland.

Fuels management activities have direct and indirect impacts to *Astragalus schmolliae* plants and habitat. Fuels management activities occur in the summer and fall when impacts to mature *A. schmolliae* plants are diminished or negligible because the seeds have matured and plants are dying back for the season. Direct impacts to the plants, such as trampling during the cutting and hauling out of wood and slash and scorching during prescribed burns, are short term because the plants will be able to resprout the following spring. Impacts to juvenile plants are not documented. Mechanical fuels reduction activities result in a low to moderate level of surface disturbance, which we believe results in little direct impact to *A. schmolliae.* However, the fuels management activities tend to facilitate nonnative species invasion by creating disturbance favored by these species. In addition to cheatgrass, Carduus nutans appears to thrive on the disturbance created by fuels management, and to outcompete *A. schmolliae* (Floyd-Hanna et al. 1999). Numerous C. nutans plants were found in all areas visited where mechanical fuels reduction activities took place (Anderson 2004, p. 73.). The canopy of *A. schmolliae* can act as a seed trap for C. nutans, which greatly increases the likelihood of negative impacts to *A. schmolliae* from competition (Anderson 2004, pp. 63, 70).

Clearing for fuel reduction impacts *A.stragalus schmolliae* in the following ways: (1) above-ground stems are directly removed; (2) plants that resprout the following spring have less water available because the soil dries due to exposure to sun and wind; and (3) invasive weeds, the native grass P. fendleriana, and seeded native grasses provide increased competition. However, we have no data that indicates the degree to which these impacts are occurring or will occur in the future. Because clearing and prescribed burns affect 19 percent of the range of *A. schmolliae,* we believe that clearing or burning for fire management may have a detrimental effect on the species. As with wildfire, the indirect effect of facilitating invasion of the habitat by cheatgrass poses a threat to the species because it increases the likelihood of more frequent fires.

Development of Infrastructure

As of 1980, about 17.7 ha (44 ac) of *Astragalus schmolliae* habitat was graded or paved for roads within MEVE, which was 1.7 percent of the habitat known in the park at that time (Friedlander 1980, p. 78). As of 2010, about 36 ha (90 ac) or 4.5 percent of the known range of *A. schmolliae* within MEVE was classified as hardened surfaces, i.e., roads, buildings, parking lots, water tanks, trails, etc. (Nelligan 2010, p.1). A recent impact was the installation of thousands of meters of underground fiber optic cables throughout the developed areas of the park (Anderson 2004, p. 70; Nelligan 2010, p. 2). Information on the number of plants destroyed or new recruits that appeared following the installation is not available (San Miguel 2010a, pers. comm.).

It is likely that a small percentage of the *Astragalus schmolliae* population has been eliminated during the development of visitor facilities in MEVE. Regular maintenance and construction projects at MEVE will continue to result in a small amount of plant mortality. Trampling of plants by people using trails, roads, and picnic areas in the developed portion of MEVE also eliminates a small number of plants (Nelligan 2010, p. 2). Likewise on the Tribal Park, most foot traffic is limited to routes used by escorted tour groups and, therefore, likely to have a very small impact on the species.

Trampling of plants by visitors and staff is an ongoing impact that does not rise to the level of a threat because it affects plants in a very limited portion of the species range in MEVE and in the Tribal Park. *Astragalus schmolliae* may recover from this kind of disturbance if the below-ground parts are not damaged, or if undamaged plants remain nearby to provide a seed source and the disturbance is not constantly repeated or followed up with additional disturbances. One attempt to transplant mature plants that were growing in a planned construction area was unsuccessful because the taproots were severed (Nelligan 2010, p. 2)

Construction of new roads, a visitor center, and campground are ongoing in MEVE. Most of the new construction is outside of *Astragalus schmolliae* habitat. Most of the disturbance in occupied habitat is related to a water pipeline, and because it is directionally drilled from one pad of about 4 by 24 m (14 by 80 ft) alongside the park road, the impact on the plants is negligible (San Miguel 2010b, pers. comm.).

The habitat for *Astragalus schmolliae* on tribal land is within the Tribal Park, which is managed for protection of its cultural and natural resources. It is an undeveloped area without surfaced roads or permanent facilities. We are not aware of any development activities on the Tribal Park that would impact *A. schmolliae* (Mayo 2010, pers. comm.).

Overall, the impact of existing development appears low, impacting about 2.3 percent of the species' entire range. MEVE will likely continue to locate major facilities outside of *Astragalus schmolliae* habitat, and minimize infrastructure within the habitat in the future. Most of the habitat within MEVE is protected from development, because it is within a National Park. Likewise, the Tribal Park is likely to remain undeveloped (Mayo 2010, pers. comm.). Therefore, development does not appear to constitute a threat to *A. schmolliae* now, nor is it likely to in the foreseeable future.

Drought and Climate Change

Drought may negatively affect *Astragalus schmolliae*. In 2002, severedrought caused most *A. schmolliae* individuals to remain dormant (Anderson 2004, p. 4). The total annual precipitation measured at MEVE in 2002 was 28 cm (11 in.), well below the average of 44 cm (17.5 in.) for 1948 to 2003. However, there were 5 years between 1948 and 1989 in which MEVE received less than 28 cm (11 in.) of precipitation. Tree ring analysis indicates that droughts were as common during the Ancestral Puebloan occupation of MEVE, from approximately *A.D. 600 to A.D. 1300,* as they are today. It is likely that drought is common enough that *A. schmolliae can* recover from its effects (Anderson 2004, p. 35), provided that severity and duration of drought does not exceed historical levels, or that threats such as weed invasion do not increase significantly as a result. Periodic drought causes *A. schmolliae* plants and seedlings to dry out during a given year, and

contributes to increased fire frequency and weed invasion. We believe that drought has a low-level direct impact on the species. It also indirectly facilitates cheatgrass invasion and increased fire frequency and therefore is a threat to the species.

Climate change projections for the Southwestern United States include increased temperatures, more intense and longer-lasting heat waves, and an increased probability of drought, that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129–134). Projections for western Colorado indicate that temperature could increase an average of 2.5 °C (4.5 °F) by 2050 (UCAR 2009, pp. 1-14).

The increasing frequency of large-scale fires is largely due to periodic drought conditions preceded by years of wet climatic conditions that allowed heavy fuel loads to accumulate (Floyd et al. 2006, p. 247). The occurrence of this specific combination of a wet season followed by drought, which is likely to be exacerbated by climate change, is unpredictable at this time. We expect that *A. schmolliae* will be affected negatively by the effects of climate change on precipitation, but the available information is too speculative to conclude that climate change now threatens the species.

Summary of Factor A

The highest threat to *Astragalus schmolliae* habitat is the invasion of nonnative cheatgrass following wildfires, prescribed fires, and fire break clearings. Recent wildfires have burned 21 percent of the pinyon-juniper woodland habitat for the species. Another 19 percent has been burned and/or cleared to discourage further spread of wildfires within MEVE. Dense stands of cheatgrass have invaded all of these areas, which cover 53 percent of the habitat on MEVE, 40 percent of the entire range of the species. Cheatgrass is highly flammable and greatly increases fire frequency on both burned and nearby unburned but disturbed habitat. Although mature *A. schmolliae* plants recover strongly after fire, cheatgrass competes with seedlings for water and nutrients, and we are unsure of their long-term reproductive success in open areas exposed to drying sun and wind. Frequent fires are likely to prevent recovery of the pinyon-juniper woodland. There are no landscape-scalemethods known to be effective in controlling cheatgrass. Therefore, we consider the dominance of cheatgrass in *occupied A. schmolliae* habitat to be a significant threat to the long-term survival of the species. Wildfires, prescribed fires, and clearings for fire breaks are considered a moderate threat to the species because they modify the habitat and facilitate the invasion of cheatgrass.

Drought facilitates increased fire frequency and, therefore, is found to be a threat to the species. Climate change may exacerbate the threat of cheatgrass invasion and more frequent wildfires, but we cannot foresee whether its effects are likely to threaten the continued existence of *Astragalus schmolliae.*

The impact of infrastructure development and visitor use is low. About 36 ha (90 ac) of *Astragalus schmolliae* habitat on MEVE have been used for roads, buildings, parking lots, etc., which is 2.3 percent of the species' entire range. No permanent development has occurred on the Tribal Park. Existing and foreseeable future development is considered a minor impact that does not threaten the continued existence of the species.

Post-fire weed control by aerial seeding of native grasses, mechanical removal, herbicides, and bio-control has reduced competition by invasive weeds other than cheatgrass, and there is little documentation of negative effects on *Astragalus schmolliae*. We consider the impacts of these activities to be low, not rising to the level of a threat to the species.

We find that *Astragalus schmolliae* is threatened by the present or threatened destruction, modification, or curtailment of the species' habitat or range, and these threats are expected to continue or increase in the foreseeable future.

B. Overutilization for commercial, recreational, scientific, or educational purposes:

We are not aware of any threats involving the overutilization or collection of *Astragalus schmolliae* for any commercial, recreational, scientific, or educational purposes. Therefore, we do not consider overutilization to be a threat to the species now, nor is it expected to become so in the foreseeable future.

C. Disease or predation:

No diseases are known to affect *Astragalus schmolliae*. Therefore, we do not consider disease to be a threat to the species now, nor is it expected to become so in the foreseeable future.

Herbivory

Seed predation by snout beetles or weevils caused loss of seeds in about 12.5 percent of *Astragalus schmolliae* plants in plots sampled in 1980 (Friedlander 1980, p. 64). Beetle predation has not been observed again since 1980, and is not considered a threat to the species. Anderson (2001, p. 11) reported severe defoliation of *A. schmolliae* by larvae of the clouded sulfur butterfly (*Colias philodice*). Aphids also appeared to have an impact on reproductive output for this species (Anderson 2001, p. 11). These events were unusual, and insect predation is considered a low-level impact that does not rise to the level of a threat.

Herbivores such as mule deer *(Odocoileus hemionus*) and cottontail rabbits (*Sylvilagus audubonii)* browse on *Astragalus schmolliae* foliage, flowers, seed pods, and seedlings. Seedling mortality due to herbivory by rabbits or deer may be 1 to 10 percent (Anderson 2004, p. 40). Feral horses and stray cattle graze within the species' range, including the burned areas, but there is no evidence that they consume many *A. schmolliae.* Mature plants usually resprout the following spring after browsing by animals (Nelligan 2010, p. 1). Because the most abundant grass (*Poa fendleriana*) associated with *A. schmolliae* on the Tribal Park is highly palatable to cattle, grazing does not appear to be an issue in the southern portion of its range. Grazing by livestock is not permitted in MEVE. We consider herbivory an ongoing low-level impact to the species that does not rise to the level of a threat.

Summary of Factor C

No diseases are known to affect *Astragalus schmolliae*. With very little herbivory observed or documented, predation does not appear to pose a threat to *A. schmolliae*. Herbicide use occurs in a small portion of the species' habitat and is conducted so as to minimize impacts to the species. Accordingly, we find no evidence that predation or disease are a threat to A. schmolliae now, nor are they expected to become so in the foreseeable future.

D. The inadequacy of existing regulatory mechanisms:

The species is offered some protection based on its presence within a National Park. The National Park Service Organic Act (1916, p. 1) states that wildlife are to be conserved and left unimpaired for future generations to enjoy. The MEVE mission is to preserve and protect more than 4,000 archeological sites and also to protect wildlife, birds, and other natural resources from willful destruction, disturbance, and removal (National Park Service 2010, p. 1). The plants are protected from visitor impacts in undeveloped areas of MEVE by regulations that restrict visitor access to designated trails, roads, and campgrounds to protect cultural resources. Visitors found hiking off developed areas or designated trails when not accompanied by a uniformed National Park Service employee are subject to penalties provided for in title 36 of the Code of Federal Regulations (maximum fine of $500 and 6 months imprisonment). The MEVE does not have a management plan specific to *Astragalus schmolliae*, nor do their draft fire management plans or draft weed

management plans specifically mention management for this species (San Miguel 2010a, pers. comm.). The draft fire management plan does not have any specific mention of managing for this species because “it would be expected to respond to fuels treatments and fire much the same as most other native perennial forbs” (Nelligan 2010, p. 3). We believe that this approach is inadequate because cheatgrass invasion will lead to more frequent and recurrent fires. These draft plans include rare plant surveys and avoidance (Nelligan 2010, p. 4.), but the plans are not finalized. The MEVE gives *A. schmolliae* special consideration when planning park projects in an effort to minimize impacts to the species (Nelligan 2010, p. 3). In 2010, MEVE began developing a specific management/conservation plan for *A. schmolliae* (Nelligan 2010, p. 3).

The habitat for *Astragalus schmolliae* on the Tribal Park is maintained as part of a 50,586-ha (125,000-ac) undeveloped area to protect cultural and environmental resources. Visitors are allowed only on guided tours. The management goal for *A. schmolliae* occupied habitat is for no ground-disturbing activities. Grazing is allowed (Clow 2010, pers. comm.), but we do not believe it substantially impacts the species. The Ute

Mountain Ute Tribe has been drafting a management plan for species at risk that is to include monitoring of *A. schmolliae* plants and habitat. The final draft plan may be completed in 2011 (Clow 2010, pers. comm.). The management plan will assist us in better understanding the extent to which the Tribe plans to conserve the species and its habitat.

Despite the positive management for *Astragalus schmolliae* that occurs within MEVE and the Tribal Park, the existing regulatory mechanisms do not address the primary threats from cheatgrass and other fire effects. Therefore, the existing regulatory mechanisms are not adequate to protect the species.

Summary of Factor D

We expect that *Astragalus schmolliae* habitat on the Tribal Park is generally protected from human disturbance by tribal regulations that do not allow public access or unauthorized activities. Human impacts in undeveloped areas of MEVE are minimized by regulations that restrict visitor access to designated trails, roads, and campgrounds to protect cultural resources. While currently needed management actions are ongoing and management plans have been drafted, no plans, policies, or regulations have been signed and implemented for the specific purpose of monitoring and protecting *A. schmolliae* from cheatgrass invasion and recurrent fires. We anticipate that MEVE and the Ute Mountain Ute Tribe will formalize their management plans within the near future.

The existing suite of local, State, and Federal laws that we evaluated do not address the primary threat to *Astragalus schmolliae* of cheatgrass invasion following fire. Additionally, the existing plans rely on the resilience of the plants and their ability to resprout after impacts, which is insufficient to provide for their recovery post-fire. Therefore, we find that the existing regulatory mechanisms for the species are inadequate and do not address the threats to the continued existence of the species.

E. Other natural or manmade factors affecting its continued existence:

Restricted Range

The global range of *Astragalus schmolliae* is restricted to pinyon-juniper woodlands on about 1,619 ha (4,000 ac) on 3 adjacent mesas. It does not grow in grasslands below the mesas or in adjacent shrublands at higher elevation on the mesas, nor has it been found in pinyon-juniper woodlands on nearby mesas. Such a restricted range makes the species vulnerable to habitat modification caused by wildfire, cheatgrass invasion, increased drought, and climate change, but is not considered a threat in itself.

Herbicides

Less than 10 percent of *Astragalus schmolliae* habitat on MEVE has been sprayed with herbicide to control identified high-density stands of *Cirsium canadense*. These herbicide applications have been performed carefully to minimize overspray that might land on native species (Nelligan 2010, p. 2). We are not aware of any use of herbicides on the tribal land habitat. Because we have no information indicating that herbicide use has affected *A. schmolliae*, we do not consider herbicide use to be a threat to the species now or in the foreseeable future.

Summary of Factor E

The small range of Astragalus schmolliae makes it vulnerable to existing and future threats, but does not constitute a threat in itself. Herbicide is used within the habitat, but is not known to affect the species. We are not aware of any other natural or manmade factors affecting the species' continued existence that present a current or potential threat to *A. schmolliae*. Therefore, we do not consider other natural or manmade factors affecting the continued existence of the species to be a threat now or within the foreseeable future.

Conservation Measures Planned or Implemented :

Exotic Plant Control

Musk thistle, Canada thistle, and other invasive exotic plants will be spot treated within portions of *Astragalus schmolliae* habitat in MEVE. Efforts will concentrate on roadsides, trail corridors, developed zones, and small burn areas on Park Mesa and Chapin Mesa. Work will primarily be done with backpack sprayers, using aminopyralid and glyphosate herbicides (Wender 2011, p.2).

Trial: Cheatgrass Control in *Astragalus schmolliae* Habitat

The MEVE Invasive Exotic Plant Management Plan calls for the aerial application of imazapic herbicide (e.g., Plateau®) following severe wildfires in sites with moderate to heavy cheatgrass infestations. In order to clarify the potential effects of aerial Plateau® applications on *Astragalus schmolliae*, MEVE will conduct an herbicide trial in summer/fall of 2011. The trial will be designed to replicate the application timing, herbicide rate, and broadcast pattern that would most likely occur under an operational aerial cheatgrass treatment scenario. We will apply 8 oz/ac of Plateau® with a calibrated CO2-powered backpack sprayer to six 0.01-acre rectangular plots within known patches of *A. schmolliae*. Three plots will be treated on approximately August 15. The remaining three plots will be treated on approximately September 15. Plots will be examined in spring and summer 2012 and 2013 to assess *A. schmolliae* mortality, foliar yellowing, growth, flower production, and seed production. Results will be compared to equivalent control plots. Pending the results of this trial, aerial Plateau® applications will be prohibited within *A. schmolliae* habitat. After the trial has concluded, a determination will be made about the effects of aerial herbicide applications. Data from the 2011 *A. schmolliae* population status survey and previous surveys in 2001 and 2003 will be used to develop a threshold of acceptable *A. schmolliae* injury and mortality resulting from herbicide application (Wender 2011, p.2).

Study: Long-term Population Trends of Schmoll's Milkvetch and its Response to Fire and Post-fire Mitigation

The Colorado Natural Heritage Program (CNHP) will conduct investigations of *A. schmolliae* starting around mid-April of 2011. The study will address questions about threats, status, trends, and fire effects. Answers to many of these questions can be addressed through revisiting permanent demographic monitoring plots established in burned and unburned areas in 2003, re-sampling survey transects that were visited in 2001 and 2003, and visiting other key sites cited in U.S. Fish and Wildlife's finding for *A. schmolliae*. In addition, plots will be randomly distributed in a balanced sampling design within each treatment type selected for this study to address questions relating to post-fire management practices. Additional

demography plots may also be needed to address impacts of management practices on demographic variables. Re-measurement of variables and attributes that will support fire management needs will be emphasized (Wender 2011, p. 2).

Summary of Threats :

SUMMARY OF THREATS

Table 1 below provides an overview of the threats to *Astragalus schmolliae.* Of these threats, we consider degradation of habitat by fire followed by cheatgrass invasion and subsequent increase in fire frequency to be the most significant threats (Table 1). Cheatgrass is likely to increase given its rapid spread and persistence in habitat disturbed by wildfires, fire and fuels management and development of infrastructure, and the inability of land managers to control it on a landscape scale. Threats to *A. schmolliae* and its habitat from nonnative plant invasion following wildfires and fire and fuels management currently affect about 53 percent (431 ha (1,066 ac)) of the species' range on MEVE and 26 percent (212 ha (524 ac)) on the Tribal Park for a total of 40 percent of the species entire known range (Table 8). Fires, fire break clearings, and drought are considered moderate threats to *A. schmolliae*. Inadequate regulations are a low-level threat to the species. Other impacts not considered threats include post-fire native grass seeding, thistle invasion, infrastructure development, trampling, herbivory, weed treatments, and pollinator availability.

TABLE 1. Threat summary for factors affecting *Astragalus schmolliae*.

Listing Factor	Threat or Impact	Scope of Threat or Impact	Intensity	Exposure %	Likelihood of Exposure	Species' Response	Foreseeable Future	Overall Threat
A	Nonnative Invasive Cheatgrass	Moderate	High	40	High	Increased fire frequency	Increasing with rapid increase possible	High
A	Wildfires	Moderate	Moderate	21	High	Strong regrowth, unknown net reproduction, Increased cheatgrass & fire frequency	More frequent	Moderate
A	Prescribed burns completed + proposed	Low	Moderate	0.37 + 0.34	High	Strong regrowth, unknown net reproduction, Increased cheatgrass & fire frequency	Continue	Moderate
A	Fire break clearing completed + proposed	Low	Low	18 + 0.25	High	Outcompeted by grasses, decline of growth, increased cheatgrass	Continue	Moderate
A	Nonnative Invasive thistles	Low	Moderate	5	High	Competition	Decline	None
A	Periodic Drought	Moderate	Moderate	97	Moderate	Plants fail to sprout, or seedlings dry up. Increased cheatgrass & fire frequency	Unpredictable but likely to increase	Moderate
A	Climate Change	Moderate?	Moderate?	97	Moderate	Increased fire frequency	Climate models predict 40-year changes	Moderate?

Listing Factor	Threat or Impact	Scope of Threat or Impact	Intensity	Exposure %	Likelihood of Exposure	Species' Response	Foreseeable Future	Overall Threat
A	Infrastructure Development	Low	Low	2.3	Moderate	Loss of habitat, loss of plants	Small increase	None
A	Trampling	Low	Low	1	Moderate	Loss of plants	Small increase	None
A	Native Grass Seeding Post-fire	Moderate	Low	21	High	Competition	Continue	None
B	None			0			Not likely to change	None
C	Herbivory	Low	Low	?	low	Plants resprout, seedlings destroyed	Likely to continue & fluctuate with herbivore population	None
C	Chemical & Mechanical Weed Treatment	Low	Low	7	Moderate	Some mortality, strong regrowth by survivors	Continue	None
D	National Park Laws & Regulations	Moderate	Low	50	Moderate	No management plan for species	Stronger protection	Low
D	Tribal Laws & Regulations	Moderate	Low	50	Moderate	No management or monitoring	Increase management actions	Low
E	Limited Range	High	Low	100	High	No range expansion	Increased effect with drought & climate change	None
E	Pollinator Availability	Low	Low	22	Low	Decreased seed production	Increase with fire	None

Listing factors include: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. ? indicates significant uncertainty.

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

We recommend continued implementation of the plans for weed control, monitoring population trends in response to invasive species, and tracking of development impacts that are now being conducted by MEVE.

Additional plant surveys to document the entire range of the species on MEVE.

Removal of feral horses from MEVE.

Avoidance of impacts to the plants during ground disturbing activities within MEVE.

Additional appropriate conservation measures for this new candidate species will depend on the results of ongoing research regarding effective measures for controlling cheatgrass and other invasive species that are competing with *Astragalus schmolliae* on MEVE.

Priority Table

Magnitude	Immediacy	Taxonmomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/Population	6
Moderate to Low	**Imminent**	Monotypic genus	7
		Species	**8**
		Subspecies/Population	9
	Non-Imminent	Monotype genus	10
		Species	11
		Subspecies/Population	12

Rationale for Change in Listing Priority Number:

Magnitude:

Magnitude: Moderate. We consider the threats that *Astragalus schmolliae* faces to be moderate in magnitude because the major threats (weed invasion facilitated by fire, management of fire and fuels management, and drought, plus inadequacy of existing regulatory mechanisms), while serious and occurring rangewide, do not collectively rise to the level of high magnitude. For example, the last known populations are not about to be completely lost due to the effects of wildfires.

The magnitude of threat Factor A is considered moderate because about 40 percent of *Astragalus schmolliae* habitat has been modified by fires and fire-related activities, followed by unprecedented invasion by cheatgrass, facilitated by drought. Factor A is shown to have occurred in the past, and it is clearly a threat today and into the future. These impacts affect the competitive ability and reproductive success of *A. schmolliae* individuals, and increase the likelihood of more frequent fire intervals in the future.

The magnitude of threat Factor D is considered low. While no plans, policies, or regulations have been signed and implemented for the specific purpose of monitoring and protecting *Astragalus schmolliae* from cheatgrass invasion and recurrent fires, we anticipate that MEVE and the Ute Mountain Ute Tribe will formalize and implement their management plans within the near future.

Imminence :

Imminence: Imminent. We consider all of the threats to be imminent because we have factual information that the threats are identifiable and that the species is currently facing them in many portions of its range. These actual, identifiable threats are covered in greater detail in Factors A and D of this finding. All of the threats are ongoing and, therefore, imminent, although the likelihood varies (Table 8). In addition to their current existence, we expect these threats, except for inadequate regulations, to continue and likely intensify in the foreseeable future.

__Yes__ Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

__No__ Is Emergency Listing Warranted?

We believe that there are enough occurrences of *Astragalus schmolliae* and the threats are not so immediate or of high enough magnitude to warrant emergency listing.

Description of Monitoring:

Tracking Impacts of Park Development on *Astragalus schmolliae* Habitat

Starting on January 1, 2011, MEVE began closely tracking disturbances from facility and utility construction and maintenance within *Astragalus schmolliae* habitat. Tracking is focused on disturbance events that displace soil, potentially damaging below-ground perennial plant structures, and disturbance events that will permanently harden ground surfaces, thereby preventing plant growth or colonization. Prior to disturbance, project sites are examined to determine if *A. schmolliae* plants are present. The number of plants observed within the project site is recorded and mitigation measures are recommended. When projects occur outside of *A.schmolliae* growing season (when plants cannot be identified), the area of disturbance is multiplied by the 2003 population density estimate of 0.037 plants/m2 to calculate the potential number of plants disturbed by the project (Wender 2011, pp. 2-3).

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

Colorado

Indicate which State(s) did not provide any information or comment:

none

State Coordination:

Colorado Natural Heritage Program provided updated element occurrence records and element global and state ranking forms.

Literature Cited:

Astragalus schmolliae References Cited

Anderson, D.G. 2001. Population Status Survey of Schmoll's Milkvetch (Astragalus schmolliae C.L. Porter). Summary of Year 1 Results. Prepared for the National Park Service, Mesa Verde National Park by the Colorado Natural Heritage Program. 25 pp.

Anderson, D.G. 2004. Population status survey of Schmoll's milkvetch (Astragalus schmolliae C.L.Porter). Final report prepared for the National Park Service, Mesa Verde National Park. 80 pp. + appendices. 85 pp.

Barnaby, R.C. 1964. Atlas of North American Astragalus. Memoirs New York Botanical Garden Vol. 13, Bronx, NY. pp. 277-278.

Colorado Natural Heritage Program. 2006. Element Global Rank Report. Biodiversity Tracking and Conservation System. Colorado State University, Fort Collins, Colorado. 3pp.

Colorado Natural Heritage Program. 2010. Element Occurrence Reports for Astragalus schmolliae. Biodiversity Tracking and Conservation System. Colorado State University, Fort Collins, Colorado. 21 pp.

Floyd-Hanna, M.L., A. Da Vega, D. Hanna, and W.H. Romme. 1997. Chapin 5 Fire Vegetation Monitoring and Mitigation. Burn Area Emergency Rehabilitation, Unpublished Report. 8pp.

Floyd, M.L., D. Hanna, and G. Salamacha. 1999. Post-fire Treatment of Noxious Weeds in Mesa Verde National Park, Colorado. Unpublished Report. 12 pp.

Floyd, M.L., W.H. Romme, and D.D. Hanna. 2000. Fire history and vegetation pattern in Mesa Verde National Park, Colorado, USA. Ecological Applications 10(6): 1666-1680.

Floyd, M.L., D.D. Hanna, and W.H. Romme. 2004. Historical and recent fire regimes in Pinyon–Juniper woodlands on Mesa Verde, Colorado, USA. Forest Ecology and Management 198 (2004) 269–289.

Floyd, M.L., D.D. Hanna, W.H. Romme, and T.E. Crews. 2006. Predicting and mitigating weed invasions to restore natural post-fire succession in MesaVerde National Park, Colorado, USA. International Journal ofWildland Fire, 15, 247–259.

Friedlander, J. D. 1980. The Status of Rare and Endangered plant Species in Mesa Verde National Park, Colorado. Master's thesis submitted to Department of Range Science, Colorado State University. 122 pp.

Hanna, D., L. Floyd-Hanna, and D.P. Hanna. 2008. Mapping successional communities in the post-fire vegetation Mesa Verde National Park. Unpublished report. 29 pp.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. An Assessment of the Intergovernmental Panel on Climate Change. 52 pp.

Isley, D. 1998. Native and Naturalized Leguminosae (Fabaceae) of the United States (exclusive of Alaska and Hawaii). Monte L. Bean Life Science Museum, Brigham Young University, Provo, UT. National Science Foundation Grand # DEB-9024537. 1007 pp.

Morris, A.B., R.S. Baucom, and M.B. Cruzan. 2002. Stratified analysis of the soil seed bank in the cedar glade endemic Astragalus vivullatus: evidence for historical changes in genetic structure. American Journal of Botany 89:29-36.

Nelligan, W.S. 2010. Schmoll's milkvetch impact summary. Unpublished data from Mesa Verde National Park. 1p.

Peterson, J.S. 1981. Status Report on Astragalus schmolliae. Unpublished report prepared for U.S Fish and Wildlife Service, Golden, Colorado. 24 pp.

Porter, C.L. 1945. Two Tioid Astragalus Novelties from the Rocky Mountain Region. Madrono, Vol. 8, pp. 100-102

Romme, W. H., L. Floyd-Hanna,and D.D. Hanna. 2003. Ancient Piñon-Juniper Forests of Mesa Verde and the West: A Cautionary Note for Forest Restoration Programs. USDA Forest Service Proceedings RMRS-P-29. 16 pp.

Romme, W., L. Floyd-Hanna, J. Chew; G. Leavesley, G. San Miguel, C. Turner, M. Miller, N. Cobb, R.

Viger, K. Ironside, R. Zirbes. 2006. Potential Influence of Cheatgrass Invasion on the Fire Regime in Mesa Verde National Park— Addendum to the Park's Draft Fire Management Plan. 11pp.

Wender, B. 2011. Schmoll's Milkvetch Status at Mesa Verde National Park (MEVE): Observations in 2010 and Actions Planned for 2011. Unpublished report . 3pp.

Personal Communications

Clow, S. 2010. Email to Al Pfister, U.S. Fish and Wildlife Service, Grand Junction, CO, from Scott Clow, Ute Mountain Ute Tribal Environmental Office, Towaoc, CO, regarding management of Astragalus schmolliae on tribal land, dated April 14, 2010. 2 pp.

Glenne, G. 2010. GIS map generated from satellite image, U.S. Fish and Wildlife Service, Grand Junction, CO, dated Mayo, 2010. 1 p.

Nelligan, W.S. 2010. Letter to Al Pfister, U.S. Fish and Wildlife Service, Grand Junction, CO, regarding Coordination and information request for Astragalus schmolliae,dated April 14, 2010. 6 pp.

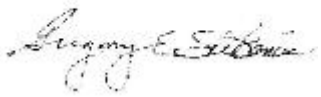
San Miguel, G. 2010a. Email to Ellen Mayo, U.S. Fish and Wildlife Service, Grand Junction, CO, regarding Astragalus schmolliae information available from MEVE, dated April 8, 2010. 2 pp.

San Miguel, G. 2010b. Email to Ellen Mayo, U.S. Fish and Wildlife Service, Grand Junction, CO, regarding new construction planned at MEVE, dated May 12, 2010. 1 p.

Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  05/31/2011
Date

Concur:  10/07/2011
Date

Did not concur: _____ _____
Date

Director's Remarks: